

Toward a Better Understanding of Ocean-Wave-Typhoon Interactions in the Western Pacific Ocean

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LONG-TERM GOALS

This project investigates the interplay among typhoon-strength winds, ocean surface waves and upper-ocean circulation during and after typhoon passages over the western Pacific Ocean and around the island of Taiwan.

OBJECTIVES

We use three numerical models and calibrate them against continuous measurements of ocean currents, temperature, wave heights and turbulence intensities from several open ocean moorings in the western Pacific. Through these calibrations, we will learn how to better represent winds, ocean currents and waves under typhoon-strength wind conditions in the western Pacific Ocean.

APPROACH

For the atmosphere, we use the Navy's operational West Pacific atmospheric model (COAMPS) and JPL wind to drive ocean waves and upper ocean circulation. For ocean waves, we use SWAN (Booji et al., 1999; Ris et al., 1999) to generate them and calibrate simulated results against observed wave heights from moorings. For the ocean circulation, we invoke the Naval Research Laboratory's Ocean Nowcast/Forecast System (ONFS, Ko et al., 2008) to simulate upper-ocean response. Resolutions of these models are sufficiently high. Through calibration and analysis of the three models and observations, we intend to identify crucial oceanic and wave processes that regulate typhoon's strength and path.

Key individuals participating in this work include Shenn-Yu Chao as the lead PI and Dong-Shan Ko of NRL, who will maintain ONFS and provide wind products. Ya-Ting Chang, visiting from Institute of Oceanography, National Taiwan University, will serve as the liaison between our modeling components and Taiwanese observation components. Her efforts along this line of investigation will constitute the bulk of her Ph.D. dissertation.

WORK COMPLETED

We have completed the construction and implementation of SWAN model for the western Pacific under typhoon-strength wind conditions. From August to October this year is the first intensive

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observation period (IOP), led by a command center in Naval Research Laboratory at Monterey, California. Ya-Ting Chang has stayed in Monterey during a good portion of IOP, and provided daily wave forecasts for the field team. Immediately after her tour of duty, she went back to Taiwan and joined cruises to recover and maintain mooring instruments. As of this writing, the IOP is still ongoing. On other fronts, we have analyzed the long-accumulated data inventory in Taiwan from the last decade.

RESULTS

Typhoons over the western Pacific Ocean ultimately impact the South China Sea. The altered circulations and heat content in the sea will, in turn, feed back to influence the next few typhoons. In this connection, we are also cooperating with Taiwanese ITOP investigators led by T. Y. Tang to look into circulation, thermodynamics and typhoon-induced disturbances in seas around Taiwan, using their long-accumulated but unpublished observations over the last decade. This effort has led to two publications this year. The first paper deals with the origin, regional variability and seasonal variation of the deep water inflow from the western Pacific to the South China Sea. The second paper deals with the intra- and inter-annual thermal structures of the South China Sea as seen from moorings and Naval Research Laboratory's Ocean Nowcast/Forecast System with and without typhoons.

IMPACT/APPLICATIONS

Last year, we used typhoon Krosa as a test case to simulate ocean waves in the western Pacific Ocean. Contrary to open ocean settings, we have demonstrated the necessity to include the effect of upper ocean currents over the Kuroshio and eddy region. Otherwise the simulated wave height is too mild east of the Luzon Strait, the wave period is too long under Krosa and the wavelength is too short east of Luzon Strait. To a certain extent, the wave field alters the ocean mixed layer, which in turn regulates the amount of upper ocean heat content released to the atmosphere. Thus, a more realistic wave field may ultimately produce better typhoon strength and track forecasts. In this light, it seems necessary to include the upper ocean currents in order to better forecast typhoons after they come into contact with the Kuroshio and its adjacent eddies. Further, a more realistic wave field may also improve upper ocean circulation and lead to better regional ocean models. Our investigation along this line will hopefully advance rapidly after this year's IOP.

RELATED PROJECTS

None in this year.

REFERENCES

- Booij, N., Ris, R.C., and L.H. Holthuijsen (1999) A third-generation wave model for coastal regions. Part I: Model description and validation, *Journal of Geophysical Research*, 104, 7649-7666.
- Ko, D.-S., P. J. Martin, C. D. Rowley, and R. H. Preller (2008) A real-time coastal ocean prediction experiment for MREA04. *Journal of Marine Systems*, 69, 17-28.
- Ris, R.C., N. Booij and L.H. Holthuijsen (1999): A third-generation wave model for coastal regions. Part II: Verification, *Journal of Geophysical Research*, 104, 7667-7682.

PUBLICATIONS

Chang, Y.-T., W.-L. Hsu, J.-H. Tai, T. Y. Tang, M.-H. Chang, and S.-Y. Chao (2009) The cold deep inflow in the South China Sea, *J. Oceanography*, Vol. 66 (No. 2), pp. 183-190. [published, refereed]

Chang, Y.-T., T. Y. Tang, S.-Y. Chao, M.-H. Chang, D. S. Ko, Y. J. Yang, W.-D. Liang, and M. J. McPhaden (2010) Mooring observations and numerical modeling of thermal structures in the South China Sea, *J. Geophys. Res.*, doi:10.1029/2010JC006293. [in press, refereed]